Empirical estimates

In this section, we will discuss the probit model estimates presented in tables 5 through 8 and the savings equation regression estimates presented in tables 9 through 11. For each empirical examination, we have defined a series of dummy indicator variables $Y_{1,i}$, $Y_{2,i}$, $Y_{3,i}$, and $Y_{4,i}$, as described above.

We are taking an A-76 competition conducted by the Navy for the functions Installation Services, Real Property Maintenance, and Base Operating Support (BOS) as the base case. Hence, we will not define dummy variables for the Navy or for the functions Installation Services, Real Property Maintenance, or BOS. We compare other potential or realized A-76 competitions to this base case. For example, we will compare a competition conducted by the Army for the Health Services function, by the Marine Corps for Social Service functions, and so forth, to the base case.

We also include a number of other variables to explain individual outcomes. Of these, the most important are number of billets, and number of billets squared. The squaring is to take account of potential nonlinear effects of number of billets. There are also a number of function*billets terms, to take account of potential interactions of billets and functions. We also interacted service with billets.

Probit model estimates

Because the probit model is a nonlinear function of the explanatory variables, the marginal effect of a unit change in one of the independent variables on the dependent variable is a complicated function. For example, consider the probit estimates presented in table 5. In this table, the dependent variable is $Y_{1,i}$, where $Y_{1,i} = 1$ if competition i is completed and $Y_{1,i} = 0$ if competition i is canceled.

In the probit model, Prob($Y_{1,i} = 1) = F(\beta' x_{1,i})$, where $F(\cdot)$ is the standard normal cumulative function. Let $X_{1,ki}$ be the kth element of the vector of independent variables $X_{1,i}$ and $\beta_{1,k}$ be the kth element of β_1. Then the marginal effect of a change in a particular variable $X_{1,ki}$ on Prob ($Y_{1,i} = 1$) is

$$\frac{\partial}{\partial X_{1,ik}} F(X'_{1,i}\beta_1) = f(X'_{1,i}\beta_1)\beta_{1,k} ,$$

where $f(\cdot)$ is the standard normal density function. Since this impact depends on the particular $X_{1,i}$ vector used, unless otherwise noted we will only discuss the direction and not the magnitude of the effect of a change in an independent variable on the Prob($Y_{1,i} = 1$).

Although there are several measures of goodness of fit for the probit model, none have the same interpretation as the R^2 measure that is common to regression models. For this reason, we will not report R^2 measures for the probit estimates. However, there is a measure of the overall significance of the independent variables in the probit model that is similar to the standard overall F-test in regression models. This is the likelihood ratio test, and it will be reported in all tables of probit model estimates.

The likelihood ratio test is a general large-sample test based on the maximum likelihood (ML) method. Let θ be the set of parameters in the model and $L(\theta)$ be the likelihood function. What the likelihood ratio says is that we first obtain the maximum of $L(\theta)$ with all the independent variables included in the model and then with the restrictions imposed by the overall hypothesis test that none of the independent variables are relevant. We then consider the ratio

$$\lambda = \frac{Max\{L(\theta)\} \text{ under the restriction all } \theta_i \text{ except the intercept are zero}}{Max\{L(\theta)\} \text{ without the restriction .}}$$

Note that λ will necessarily be less than 1 since the restricted maximum will be less that the unrestricted maximum. If the restrictions are not valid, λ will be significantly less than 1. If they are valid, λ will be close to 1. The LR test consists of using $-2 \log_e \lambda$ as a χ^2 with k degrees of freedom, where k is the number of explanatory variables in the probit model.

Probit 1 : The probability of completion

Table 5 examines whether a particular A-76 competition was completed. In this case, as in all other probit and OLS results presented here, our variables are collectively significant. This is tested explicitly by the likelihood ratio test statistics reported for the probit estimates and by the overall *F*-statistic reported for the regression results. All these statistics are significant, indicating that the independent variables have explanatory power.

Ignoring the effect of billets, table 5 shows that a base case naval competition for Installations Services, Real property Maintenance, or BOS had approximately a .76 probability (76 percent chance) of being completed. This probability is computed as the integral for the normal density function from $-\infty$ to the intercept, which equals .705.

Ignoring the interaction terms, increasing the number of billets tended to decrease the probability of completion (the coefficient on billets is negative). As the number of billets increased for a given competition, the impact of the effect of billets began to lessen very slightly as indicated by the coefficient on the billets squared variable. Over the sample considered, an increase in the number of billets would never have the effect of making completion of a competition more likely.

Marine Corps and DoD agency competitions were significantly less likely than Navy competitions to be completed, all else held equal. There were no significant differences between Navy and the Army or Air Force competitions.

If we choose one branch of the armed forces and a given number of billets, we find that all competitions except Social Services were significantly less likely to be completed than the base case of Installation Services, Real Property Maintenance, and BOS. This effect appears strongest for Manufacturing and Fabrication competitions, as indicated by the -1.94 estimate on this dummy variable. The difference for Social Services competitions is barely significant, which indicates a possibility that there is no real difference between Social Services and the base case (accounting for sample error of the estimates).

Table 5. Probit 1: The probability of completion

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Constant	0.705	0.0543	12.980	0.00
Announced billets[a]	-0.002 68	0.000774	-3.471	0.00
Announced billets^2	0.00000337	0.000000827	4.074	0.00
DoD agencies	-1.24	0.128	-9.690	0.00
Army	0.0649	0.0705	0.920	0.36
Air Force	0.0579	0.0606	0.955	0.34
Marines	-0.629	0.153	-4.127	0.00
Social Services	0.208	0.0992	2.102	0.04
Other Nonmanufacturing Operations	-0.541	0.0616	-8.789	0.00
Intermediate Maintenance	-0.0466	0.1 IO	-0.423	0.67
Health Services	-1.16	0.201	-5.778	0.00
Automatic Data Processing	-0.964	0.113	-8.501	0.00
Education and Training	-1.84	0.227	-8.100	0.00
Manufacturing and Fabrication	-1.94	0 . 4 6 3	-4.201	0.00
Depot Maintenance	-1.08	0.303	-3.551	0.00
RDT&E Support	-1.03	0.299	-3.452	0.00
DoD agency billets	-0.000529	0.00172	-0.308	0.76
Army billets	-0.000948	0.000713	-1.330	0.1 8
Air Force billets	0.000368	0.000749	0.492	0.62
Marine billets	-0.00306	0.00205	-1.489	0.14
Social Service billets	-0.003 18	0.00110	-2.897	0.00
Other Nonmanufacturing Operations billets	0.00280	0.000876	3.196	0.00
Intermediate Maintenance billets	-0.000851	0.000708	-1.202	0.23
Health Services billets	-0.00634	0.00771	-0.823	0.41
Automatic Data Processing billets	0.00191	0.00265	0.722	0.47
Education and Training billets	0.000619	0.00130	0.476	0.63
Manufacturing and Fabrication billets	0.00053 6	0.00165	0.326	0.74
Depot Maintenance billets	0.00234	0.00259	0.903	0.37
RDT&E Support billets	0.00335	0.00349	0.958	0.34

a. Announced positions were used instead of baseline billets because baseline billets was missing for many of the canceled studies.

The dependent variable is completion status

Likelihood ratio test: 537.4 w/ 28 df

		Actual completion 0	Actual completion 1
Predicted completion	0	577	252
	1	861	1879

Percentage of correct predictions 0.688

Holding the branch of service and function type fixed, we find that increasing the number of billets did not change the effect of a particular function on the likelihood of a competition being completed except for Other Nonmanufacturing Operations and Social Services. We thus conclude, for example, that increasing the number of billets for a Navy Depot Maintenance competition would have the same effect as increasing the number of billets in the base case.

There are some odd results that don't have a ready explanation. We find Other Nonmanufacturing Operations less likely to be completed for small competitions. However, if the number of billets is more than 200, Other Nonmanufacturing Operations competitions are more likely to be completed than in our base case.

We found opposite results for Social Service competitions. In Social Service competitions where the number of billets is less than 70, the probability of completion would be greater than in our base case. However, if the number of billets was 70 or greater, Social Service competitions would be less likely to be completed than in our base case.[13]

In summary, larger competitions are less likely to be completed. The Army, Air Force, and Navy don't differ much in number of completions, but they complete more than the Marines and DoD agencies, and there are differences across the different functions.

Probit 2: The probability that MEO equals baseline

Table 6 shows how some characteristics affect the probability that the in-house competitor's bid is the same as the number currently engaged in the task. That is, the dependent variable equals 1 if the in-house team's MEO is the same as the baseline billets and equals zero if the in-house team's MEO was a reduction in baseline billets.

13. This is calculated by comparing -0.003 on the Social Service interaction variable to 0.205 for the Social Service dummy variable.

Table 6. Probit 2: The probability that MEO = baseline

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Constant	0.634	0.0725	8.745	0.00
Billet	-0.0139	0.00175	-7.947	0.00
$Billet^2$	0.00000994	0.00000172	5.777	0.00
Percent military	-0.692	0.141	-4.905	0.00
Military billets	0.00112	0.00194	0.578	0.56
Multifunction	-0.320	0.0890	-3.599	0.00
DoD agencies	-0.660	0.298	-2.216	0.03
Army	-0.442	0.0929	-4.762	0.00
Air Force	-0.280	0.0804	-3.487	0.00
Marines	-0.366	0.315	-1.163	0.24
Social Services	0.229	0.11 8	1.936	0.05
Other Nonmanufacturing	-0.409	0.0905	-4.524	0.00
Intermediate Maintenance	-0.00789	0.127	-0.062	0.95
Health Services	0.00897	0.238	0.038	0.97
Automatic Data Processing	0.375	0.236	1.587	0.11
Education and Training	-0.468	0.543	-0.863	0.39
Manufacturing and Fabrication	0.810	0.876	0.925	0.36
Depot Maintenance	-0.439	0.519	-0.846	0.40
RDT&E Support	-0.614	0.456	-1.345	0.18
DoD agency billets	-0.0127	0.0145	-0.874	0.38
Army billets	0.00532	0.00171	3.116	0.00
Air Force billets	0.00115	0.00163	0.704	0.48
Marines billets	-0.00962	0.01 10	-0.878	0.38
Social Service billets	0.00 142	0.00275	0.515	0.61
Other Nonmanufacturing Operations billets	-0.000890	0.00279	-0.319	0.75
Intermediate Maintenance billets	0.000466	0.00136	0.343	0.73
Automatic Data Processing billets	-0.0186	0.0104	-1.785	0.07

The dependent variable is whether MEO = baseline

Likelihood ratio test: 392.4 w/ 26 df

		Actual Y_2 0	Actual Y_2 1
Predicted Y_2	0	784	304
	1	370	673

Percentage of correct predictions 0.684

Our explanatory variables in table 6 change somewhat from table 5. We do not examine interactions of the number of billets with services for Education and Training, Manufacturing and Fabrication, Depot Maintenance, and RDT&E Support. We do add variables to see whether percent of billets that are military has an effect and also to see how this effect interacts with the total number of billets. This interaction term reduces to the number of military billets. We include both these terms to attempt to capture linear and nonlinear effects of the military billets on this probability. We also add a term for Multifunction bids, where two tasks or more are combined into one Request for Proposal, to see whether bundling had a significant effect.

For our base case, ignoring effects of numbers of billets, there was approximately a .73 probability (73 percent chance) that the in-house competitor would not reduce the number of billets for a competition. As before, this probability is computed as the integral for the normal density function from $-\infty$ to 0.634. Here again, ignoring the interaction terms, the effect of increasing the number of billets was to decrease the probability of bidding an MEO equal to baseline billets. This effect tended to lessen as the number of billets increased, but no increase in the number of billets would have made bidding MEO equal to baseline more likely over the sample. Only for a number of billets greater than 1,400 would this occur, as indicated by the -0.014 coefficient on the billets variable and the 0.00001 coefficient on the billets squared variable.

Increasing the percent of military billets tended to lessen the probability of bidding the MEO equal to baseline billets, and this effect did not significantly decrease as the number of billets increased.

Ignoring the interaction terms with billets, the probability of bidding the MEO equal to baseline billets was often significantly different for different branches of the military. The exception to this is the Marines who did not differ significantly from the Navy. The Army and Air Force were significantly less likely to bid the MEO equal to baseline billets, holding all other variables fixed and ignoring the interaction terms. DOD agencies were also significantly less likely than the base case to bid the MEO equal to baseline billets. Bids from bundling, as shown by our Multifunction term, significantly reduced the probability of bidding the MEO equal to baseline billets.

Change in function type did make a significant difference in general for the probability of bidding the MEO equal to baseline billets. The only exception was for Other Nonmanufacturing, where the probability fell significantly.

In general, there were no significant interaction effects between our terms with the number of billets for this probability. The exception here was for the Army. As the number of billets rose, the reduction in probability of bidding the MEO equal to baseline billets between the Army and the Navy, holding function type fixed, tended to evaporate. In cases where the number of billets was greater than 84, the probability that the Army would bid a reduction would be greater than that for the Navy.

In summary, MEOs have been more likely to produce savings in larger activities, especially those with military billets; in the Army, Air Force, and DoD agency competitions; and in multifunctional competitions.

Probit 3: The probability of contractor win given MEO equals baseline

Table 7 looks at the likelihood of a contractor win. This is the same as the probability that the cost of the in-house bid is greater than 1.1 times the relevant contractor bid, for the subset of studies where the Most Efficient Organization equaled the baseline contract case, pursuant to the general guidelines of the A-76 competitions. Here our dependent variable was 1 if the adjusted contractor bid was the lesser, and 0 if the in-house bid was the lesser.

Our variables for this table are the same as those for table 6. For the typical base case, ignoring the effects of billets, the probability that a contractor would win would be about .46 (or a 46 percent chance), as computed from the integral for the normal density function from $-\infty$ to -0.088. Ignoring the interaction terms, at the median level of 14 billets, this probability would be .51.

Table 7. Probit 3: The probability of contractor win given MEO = baseline

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Constant	-0.0883	0.0958	-0.922	0.36
Billet	0.00759	0.00383	1.983	0.05
$Billets^2$	-0.00000570	0.00000766	-0.743	0.46
Percent military	0.224	0.256	0.874	0.38
Military billets	0.00644	0.00833	0.773	0.44
Multifunction	-0.318	0.152	-2.095	0.04
DoD agencies	-0.567	0.443	-1.280	0.20
Army	-0.326	0.149	-2.189	0.03
Air Force	0.335	0.130	2.572	0.01
Marines	0.190	0.687	0.276	0.78
Social Services	0.551	0.236	2.338	0.02
Other Nonmanufacturing Operations	-0.350	0.138	-2.538	0.01
Intermediate Maintenance	-0.249	0.189	-1.321	0.19
Health Services	-1.104	0.377	-2.928	0.00
Automatic Data Processing	-0.270	0.297	-0.907	0.36
Education and Training	6.561	5013.8	0.001	1.00
Manufacturing and Fabrication	1.893	7129.1	0.000	1.00
Depot Maintenance	-6.258	3983.2	-0.002	1.00
RDT&E Support	-0.553	0.925	-0.597	0.55
DoD Agency billets	0.0245	0.0327	0.748	0.45
Army billets	0.00348	0.00478	0.729	0.47
Air Force billets	-0.000987	0.00516	-0.191	0.85
Marine billets	-0.137	0.118	-1.157	0.25
Social Service billets	0.00933.	0.0183	0.509	0.61
Other Nonmanufacturing Operations billets	0.00874	0.00660	1.325	0.19
Intermediate Maintenance billets	-0.00450	0.00486	-0.926	0.35
Automatic Data Processing billets	0.00764	0.0170	0.450	0.65

The dependent variable is contractor win

		Actual Y_3	
Likelihood ratio test: 132.7 w/ 26 df		0	1
Predicted Y_3	0	303	181
	1	164	329
Percentage of correct predictions	0.647		

As billets increased, the probability of contractors winning tended to increase. There was also a very insignificant nonlinear decrease to this effect. No interaction of billets with any other variable was found to make a significant difference in results.

There were some significant differences between the branches of the military. Contractors were significantly less likely to win for Army tasks. On the other hand, contractors were significantly more likely to win for Air Force tasks. In fact, the quantitative differences between the Navy base case and the Army; and between the Navy base case and the Air Force are almost the same but in opposite directions. The differences in probability for contractor wins between the Navy and the Marines are not significant, and there were no significant differences for DoD agencies either.

For Multifunction tasks, contractors were significantly less likely to be the winners, so again in this case, bundling makes a difference. Contractors were significantly more likely to win for Social Service contracts than for the base case. However, contractors were significantly less likely to win for Other Nonmanufacturing Operations and for Health Services. There were no other significant differences for service types.

Data problems in the form of a limited number of observations for certain functions were relatively severe for this examination, leading to standard errors many orders of magnitude greater than some coefficient estimates for some functions, such as Manufacturing and Fabrication and Education and Training. It is thus possible that additional data might suggest some likelihood of contractors winning for these functions or the converse.

Note that in table 7, the *P*-values are not easy to interpret but the t-ratios are. The fact there are three variables for which the t-values are zero, and only seven variables for which $|t|$ is greater than two, suggests that there might be some data problems. However, the percentage of correct predictions, 0.65, is not bad.

To summarize, in cases where MEOs are equal to the baseline, the probability of the contractor winning is highest in the Air Force and lowest in the Army; there are some differences in contractors winning across functions; contractors are less likely to win multifunctional competitions; and contractors are more likely to win larger activities.

Probit 4: The probability of contractor win given MEO is less than baseline

Table 8 examines probabilities that contractor bids were lower than in-house bids where the Most Efficient Organization was less than the baseline. The definition for the dependent variable is the same for this table as for table 7, and the conditions under which contractor bids were considered lower, pursuant to regulations governing A-76 competitions, remain the same as well.

The explanatory variables for this table are the same as those in table 7. Contractors were much less likely to win in these circumstances as compared to table 7. For the typical base case under these conditions, ignoring the effects of billets, the probability that a contractor would win would be about .33. This is computed as the integral for the normal density function from $-\infty$ to -0.4425. Ignoring interaction effects, at the median billet level of 14 this probability would be approximately .35.

More of the coefficient estimates are significant for this probit equation, which suggests significant differences among the cases examined. Ignoring interaction effects, as numbers of billets increase, the probability for winning contractor bids relative to the base case increases significantly. For bids of more than 111 billets, the probability of the contractor winning the competition is greater than 50 percent. A quadratic decrease was again indicated for this effect, but this does not have noticeable numerical impact over the sample considered. The coefficient for the interaction variable of billets and military percentage was also significant (military percentage itself was not), suggesting a nonlinear increase in probability of low contractor bids as both military percentage and number of billets are increased. The only significant interaction effects of billets and function was for Social Service billets.

The only significant difference between the base case and those for other branches of the military occurred for the Air Force. Contractors were significantly more likely to win for Air Force tasks. There were no

Table 8. Probit 4: The probability of contractor win given MEO < baseline

Variable name	Estimated coefficient	Standard error	T-ratio	f-value
Constant	-0.443	0.106	-4.163	0.00
Billet	0.00425	0.00145	2.930	0.00
$Billets^2$	-0.00000432	0.00000149	-2.900	0.00
Percent military	0.296	0.164	1.799	0.07
Military billets	0.00252	0.00116	2.178	0.03
Multifunction	-0.442	0.107	-4.129	0.00
DoD agencies	0.645	0.683	0.944	0.35
Army	0.190	0.130	1.469	0.14
Air Force	0.534	0.112	4.755	0.00
Marines	0.495	0.314	1.578	0.11
Social Services	1.505	0.229	6.558	0.00
Other Nonmanufacturing Operations	-0.161	0.107	-1.509	0.13
Intermediate Maintenance	0.462	0.183	2.528	0.01
Health Services	-0.669	0.357	-1.874	0.06
Automatic Data Processing	0.117	0.289	0.404	0.69
Education and Training	-0.532	0.650	-0.818	0.41
Manufacturing and Fabrication	5.886	2601.2	0.002	1.00
Depot Maintenance	-5.382	904.1	-0.006	1.00
RDT&E Support	0.465	0.467	0.995	0.32
DoD Agency billets	-0.0616	0.0360	-1.711	0.09
Army billets	-0.000176	0.00132	-0.134	0.89
Air Force billets	-0.00244	0.00143	-1.709	0.09
Marine billets	-0.00119	0.00453	-0.262	0.79
Social Services billets	-0.00463	0.00243	-1.906	0.06
Other Nonmanufacturing Operations billets	0.00120	0.00139	0.864	0.39
Intermediate Maintenance billets	0.000849	0.00144	0.590	0.56
Automatic Data Processing billets	-0.00135	0.00536	-0.252	0.80

Likelihood ratio test: 184.5 w/ 26 df

		Actual Y_4 0	Actual Y_4 1
Predicted Y_4	0	407	221
	1	179	347

Percentage of correct predictions 0.653

significant differences between other branches and the Navy, nor did DoD agencies show significant differences. The effects that were observed would suggest that contractors were more likely to win for all other branches and DoD agencies relative to the Navy. In-house contractors tended to be significantly more likely to win for Multi-function tasks, suggesting a bundling effect for these cases as well.

There were significant differences between the base case and for only two functions: Social Services and Intermediate Maintenance. Ignoring interaction effects, contractors were significantly more likely to win on these services, all else held equal. The difference for Health Services was almost significant, with in-house bids being lower for this function.

There are problems in table 8 similar to those in table 7. The *P*-values are not meaningful, but the *t*-ratios are. The *t*-ratios are almost zero for two cases, but for eight cases we have $|t| > 2$, and the percentage of correct predictions is 0.65. Thus, there are some data problems, but they are not severe.

In summary, in those cases where the MEO is below the baseline, contractors were more likely to win in larger competitions, in Air Force competitions, and in single function competitions.

This completes our discussion of our probit tables. The remaining tables discuss factors affecting observed savings under the various conditions in which they were observed. Each regression for the succeeding table is an OLS regression. Conditional on the case under consideration, R^2's have clear meaning and will be reported in turn. The variables for all these regressions are collectively significant and substantial, but varying proportions of variation are explained for each.

OLS model estimates

The dependent variables for each of the succeeding tables are thousands of dollars saved. Our independent variables remain the same as in the previous tables.

C_1: Savings estimates given the contractor wins and the MEO equals the baseline

Table 9 discusses savings when the Most Efficient Organization equaled the baseline, and the contractor won. Mean savings were $367,000. For the baseline case, we estimate that savings increased as the billets variable increased for small numbers of billets and decreased for large numbers of billets, with maximum savings reached at approximately 2,000 billets. This maximum savings size should be used with caution since the billets^2 variable is insignificant and very few competitions were anywhere near this size.

Increases in the Percent Military tend to decrease savings in this case, but the effect is counteracted by the the effect of the number of military billets. The total effect, for a typical study, was for savings to increase faster for competitions with more military billets.

There were no significant differences in savings between branches of the military and DoD agencies when compared to the Navy. However, contractor savings for the Air Force were almost significantly different. The Multifunction coefficient was not significant or of great magnitude here, so bundling does not appear to be relevant for these cases.

Some differences in savings were evident for different functions. Ignoring interaction effects, for a given number of billets, savings were significantly less for Social Services and Other Nonmanufacturing Operations than for the base case, and enormously more (over $2 million) for Manufacturing and Fabrication than for the base case. These effects were significantly counteracted in some cases as the number of billets was allowed to increase. As the number of billets increases, there is a significant interaction with the Air Force and savings tended to increase.

C_3: Savings estimates given the contractor wins and the MEO is less than the baseline

Table 10 discusses savings when the Most Efficient Organization was less than the baseline and the contractor won. The mean of these savings was substantially more, $1.7 million.

Table 9. C_1 : Savings when MEO = baseline and contractor won

Variable name	Estimated coefficient	Standard error	T-ratio	f-value
Constant	115.16	29.06	3.962	0.00
Billet	9.105	0.973	9.359	0.00
$Billet^2$	-0.00227	0.00128	-1.775	0.08
Percent military	-296.4	70.03	-4.233	0.00
Military billets	21.4	1.61	13.310	0.00
Multifunction	-28.7	45.6	-0.631	0.53
DoD agencies	-10.04	106.2	-0.095	0.92
Army	0.785	48.2	0.016	0.99
Air Force	53.49	34.5	1.551	0.12
Marines	-64.19	336.4	-0.191	0.85
Social Services	-164.97	41.6	-3.968	0.00
Other Nonmanufacturing Operations	-149.61	44.6	-3.352	0.00
Intermediate Maintenance	-49.97	55.0	-0.909	0.36
Health Services	-186.48	155.4	-1.200	0.23
Automatic Data Processing	-92.14	102.8	-0.896	0.37
Education and Training	-83.83	189.5	-0.442	0.66
Manufacturing and Fabrication	2525.8	337.9	7.475	0.00
RDT&E Support	-159.23	272.7	-0.584	0.56
DoD Agency billets	8.276	5.43	1.523	0.13
Army billets	-1.68	1.28	-1.313	0.19
Air Force billets	2.891	1.16	2.498	0.01
Marine billets	17.34	81.4	0.213	0.83
Social Services billets	7.170	1.88	3.808	0.00
Other Nonmanufacturing Operations billets	3.035	1.74	1.742	0.08
Intermediate Maintenance billets	-5.41	0.440	-12.300	0.00
Automatic Data Processing	-3.86	5.64	-0.684	0.49

The dependent variable is Savings

R^2	0.484
F (25, 484)	166.0

Table 10. C_3: Savings when MEO < baseline and contractor won

Variable name	Estimated coefficient	Standard error	T-ratio	P-value
Constant	182.4	464.2	0.393	0.69
Billet	30.3	5.68	5.332	0.00
$Billet^2$	-0.0039	0.0053	-0.729	0.47
Percent military	-203.3	625.6	-0.325	0.75
Military billets	9.08	3.68	2.468	0.01
Multifunction	-799.5	469.6	-1.703	0.09
DoD agencies	225.8	1859	0.122	0.90
Army	269.6	556.0	0.485	0.63
Air Force	-284.6	454.2	-0.627	0.53
Marines	201.3	I I 78	0.171	0.86
Social Services	-311.7	677.8	-0.460	0.65
Other Nonmanufacturing Operations	-533.9	444.0	-1.202	0.23
Intermediate Maintenance	792.9	609.1	1.302	0.19
Health Services	-915.6	1,839	-0.498	0.62
Automatic Data Processing	-31 a.3	1,247	-0.255	0.80
Education and Training	-9,525.7	3,211	-2.967	0.00
Manufacturing and Fabrication	-1,121.0	3,637	-0.308	0.76
RDT&E Support	4,064.8	1,343	3.027	0.00
DoD agency billets	-5.19	122.8	-0.042	0.97
Army billets	-1.24	5.29	-0.235	0.81
Air Force billets	7.48	2.91	2.571	0.01
Marine billets	-6.87	13.7	-0.502	0.62
Social Services bi II ets	-12.1	8.40	-1.436	0.15
Other Nonmanufacturing Operations billets	0.988	4.96	0.199	0.84
Intermediate Maintenance billets	-18.6	3.78	-4.922	0.00
Automatic Data Processing billets	-10.5	19.3	-0.542	0.59

The dependent variable is Savings	
R^2	0.481
F (25, 842)	20.3

The direct effects of the Billets variable, ignoring interactions and considering only the Navy base case, are qualitatively similar to those in table 9. However, there are large differences in the coefficients for the Billets variable in table 10 when compared to table 9, and the Squared Billets effect is clearly not significant in table 10.

The effect of Percent Military and Percent Military*billets on savings is the same as in table 9 as well. Coefficients for both variables are significant; the latter is especially so.

There were no significant military branch differences in savings, and the difference between the base case and that for DoD agencies was not significant. The magnitude of the Multifunction (or bundling) coefficient was substantial but insignificant (although nearly significant), suggesting a bundling decrease in savings, all else held equal.

We observed few significant direct function differences in savings. The two cases where the differences were significant were for Education and Training and for RDT&E Support. In the several millions of dollars for each case, there was a reduction in savings versus the base case for the first and an increase versus the base case for the second. Billets did not generally change these effects through interaction. However, the coefficient was significant for Intermediate Maintenance interaction and for the interaction with the Air Force.

I_2: Savings estimates given the in-house team wins and the MEO was less than the baseline

Table 11 discusses savings where in-house team won and the Most Efficient Organization was less than the baseline. The effects observed showed a relatively consistent pattern. Mean savings for this case were $598,500.

The direct effect of Billets was to increase savings both linearly and quadratically. Coefficients for both were strongly significant. Neither Percent Military nor Percent Military*billets made significant differences in savings relative to the base case.

Ignoring interaction effects, military branch differences were relevant. The coefficient for DoD agencies was insignificant, as was that for the Marines, suggesting the differences in savings between these branches and the Navy were insignificant, all else held equal. On the other hand, savings for Army and Air Force tasks tended to be significantly greater than those for the Navy. These differences in savings tended to fall significantly as the number of billets increased for

Table 11. I_2: Savings when the MEO < baseline and the in-house team won

Variable name	Estimated coefficient	Standard error	T-ratio	f-value
Constant	18.9	64.7	0.292	0.77
Billet	12.1	0.965	12.500	0.00
$Billet^2$	0.00286	0.00114	2.500	0.01
Percent military	-91.3	117.2	-0.779	0.44
Military billets	1.22	1.17	1.042	0.30
Multifunction	150.8	64.8	2.329	0.02
DoD agency	135.0	222.3	0.607	0.54
Army	195.3	80.9	2.415	0.02
Air Force	158.8	75.3	2.109	0.04
Marine	32.2	278.4	0.116	0.91
Social Services	-155.3	208.9	-0.744	0.46
Other Nonmanufacturing Operations	-118.3	68.1	-1.738	0.08
Intermediate Maintenance	-58.3	136.2	-0.428	0.67
Health Services	-210.6	189.1	-1.114	0.27
Automatic Data Processing	65.0	180.7	0.360	0.72
Education and Training	-24.7	315.7	-0.078	0.94
Depot Maintenance	55.6	286.1	0.194	0.85
RDT&E Support	302.4	431.4	0.701	0.48
DoD agency billets	-6.42	2.56	-2.510	0.01
Army bit lets	-2.10	1.01	-2.073	0.04
Air Force billets	-3.39	1.21	-2.806	0.01
Marine billets	-3.58	5.49	-0.652	0.51
Social Services billets	-0.792	1.95	-0.406	0.68
Other Nonmanufacturing Operations billets	1.49	1.02	1.465	0.14
Intermediate Maintenance billets	1.50	0.983	1.530	0.13
Automatic Data Processing billets	-9.62	3.78	-2.544	0.01

The dependent variable is $Savings_2$	
R^2	0.785
F (25, 560)	82.8

each branch by comparable amounts as indicated by the respective coefficients for the Army and Air Force interaction terms of -2.0985 and -3.3853. This interaction effect with Billets was significant for DoD agencies as well.

Ignoring interaction effects, no coefficient for differences in function was significant, suggesting no substantial differences in savings by function, all else held equal. Only for Automatic Data Processing and RDT&E Support was there any suggestion of increased savings over the base case. For all other functions, savings were the same or less than the base case. There was a significant interaction effect for Automatic Data Processing and Billets, suggesting that whatever difference there was between the base case and that for Automatic Data Processing tended to be reduced as the number of billets increased.

Summary of empirical estimates

It is difficult to draw general conclusions for tables 5 through 11 as a whole. Their role will be to predict overall savings. Size of the competition matters, but in nonlinear ways. In general, larger competitions are more likely to be canceled, but they also produce the biggest savings.

Another relevant general conclusion concerns military branch differences. Only in table 5 was the Marine variable significant. This suggests that once a competition occurs, the significant differences in savings and the likelihood of winning will be found between the Navy and Marines on one side and the Army and the Air Force on the other. This does not translate into direct guidance for particular tasks. Outcomes in the various tables for the Air Force coefficient in particular varied substantially from table 6 to table 11. But it does suggest that further examination of these military-branch differences to identify relevant factors may be fruitful.

Finally, the Multifunction variable was significant in numerous tables. Roughly speaking, it tended to increase the likelihood that in-house would win contracting bids, to increase savings if in-house did win, and decrease savings if contractors won, though this last effect was not significant. This suggests that information asymmetries are relevant for the contracting process, and that they have real effects on both costs and bidding strategies.